

# PATENT ABSTRACTS OF JAPAN

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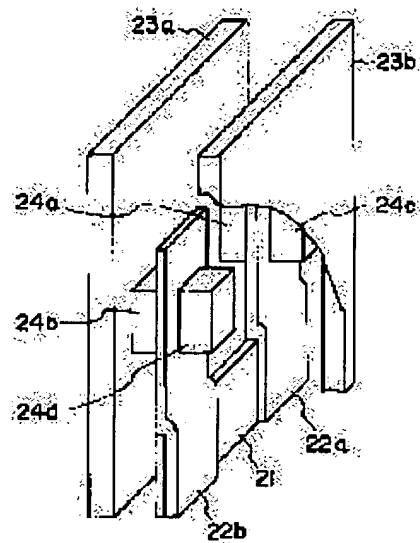
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## (54) MAGNETIC HEAD, MAGNETIC RECORDER AND PRODUCTION OF MAGNETIC HEAD

### (57)Abstract:

**PURPOSE:** To prevent destruction by an overvoltage, overcurrent and discharge of static electricity by inserting diodes between a magneto-resistive element and shields for shielding the element.

**CONSTITUTION:** First and second leading-out conductors 22a, b consisting of copper films having a thickness of about 100 $\mu$ m; are mounted at both ends of the band-shaped MR element 21 having a thickness of about 340 $\text{\AA}$  and a sense current is supplied thereto; Both sides thereof are held by the first and second magnetic shields 23a, b consisting of soft magnetic materials, such as 'Permalloy (R)' having a thickness of 2 to 3 $\mu$ m, by which the MR head is composed. The respective first and second leading-out conductors 22a, b and the respective first and second magnetic shields 23a, b are connected via the diodes 24a to (d). The resistance of the MR element 21 is 5 to 10  $\Omega$ , the sense current is 16 to 20mA and the voltage across the element is 0.2V at the max. at the time of ordinary operation of the element. The voltage at which the diodes 24a to (d) conduct is about 0.6V and does not, therefore, hinder the ordinary operation but the diodes conduct at the voltage higher than the voltage to prevent the destruction of the MR element 21.



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## DETAILED DESCRIPTION

## [Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the manufacture approach of the magneto-resistive effect mold magnetic head equipped with magnetic shielding used for a magnetic disk drive and a magnetic tape unit, a magnetic recording medium, and the magnetic head in more detail about the manufacture approach of the magnetic head, a magnetic recording medium, and the magnetic head.

[0002]

[Description of the Prior Art] In recent years, the high performance magnetic head is demanded with large-capacity-izing of the magnetic disk drive used as external storage of a computer. The magneto-resistive effect mold magnetic head (an MR head is called hereafter.) which fills this request and from which it is not dependent on the rate of a record medium, and high power is obtained as a thing attracts attention.

[0003] Moreover, in order to perform informational read-out or writing correctly with the formation of high density record, it is necessary to intercept the line of magnetic force which intercepts the line of magnetic force from fields other than the read-out field of a magnetic disk at the time of read-out, or reaches fields other than a write-in field. For this reason, in an MR head, magnetic shielding may be prepared on both sides of a magnetic-resistance-element layer (MR component layer is called hereafter.).

[0004] Drawing 9 (a) is the perspective view showing the MR head equipped with magnetic shielding of the conventional example. in drawing 9 (a), MR component layer, 2a, and 2b were connected with the both ends of MR component layer 1 for 1 -- pulling out -- a conductor -- it is -- a cash drawer -- a conductor -- 2a -- a sense current -- MR component layer 1 -- flowing -- a cash drawer -- a conductor -- 2b flows a sense current out of MR component layer 1. 3a and 3b are MR component layer 1 and magnetic shielding which pulled out and was prepared on both sides of conductor 2a and 2b through a non-illustrated insulator layer.

[0005] This MR head is attached in the side attachment wall of a magnetic-head slider, surfaces on the rotating magnetic disk, and detects the signal magnetic flux from a magnetic disk. If signal magnetic flux goes into MR component layer 1, the resistance of MR component layer 1 changes, and it will become change of an electrical potential difference and will appear. This is taken out through a regenerative circuit.

[0006]

[Problem(s) to be Solved by the Invention] However, in the above-mentioned MR head, if a surge is in a sense current or an excessive current flows accidentally, MR component layer 1 will be overheated and damaged by fire. moreover, it is shown in drawing 9 (b) -- as -- under creation of the magnetic head -- or the magnetic shielding 3a and 3b which has floated electrically during the handling of the created magnetic head may be charged For this reason, it discharges through an insulator layer between magnetic shielding 3a and 3b and MR component layer 1, and MR component layer 1 may be destroyed.

[0007] This invention is created in view of the trouble of the starting conventional example, and aims at offering the magneto-resistive effect mold magnetic head which can prevent that MR component is destroyed by discharge by overvoltage, the excessive current, or static electricity.

[0008]

[Means for Solving the Problem] The 1st which draws the sense current which it connects [ 1st ] with a magnetic resistance element and said magnetic resistance element, respectively, and the above-mentioned technical problem flows into said magnetic resistance element, or flows out of said magnetic resistance element, and the 2nd pull out. A conductor, The 1st and 2nd magnetic shielding which said magnetic resistance element, said 1st [ the ], and said 2nd [ the ] pull out through an insulator layer, and sandwiches a conductor, Said 1st protection component through which

the 1st pulls out, and connects with a conductor and said 1st magnetic shielding, and it flows to the electrical potential difference beyond a convention, Said 2nd protection component through which the 2nd pulls out, and connects with a conductor and said 1st magnetic shielding, and it flows to the electrical potential difference beyond a convention, Said 3rd protection component through which the 1st pulls out, connects with a conductor and said 2nd magnetic shielding, and it flows to the electrical potential difference beyond a convention, Said 2nd [ the ] pulls out, connect with a conductor and said 2nd magnetic shielding, and it is attained by the magnetic head which has the 4th protection component through which it flows to the electrical potential difference beyond a convention. It is attained by the magnetic head of a publication by the 1st invention characterized by said 1st thru/or 4th protection component being diode, reference diode, or a varistor the 2nd. In the 3rd, both [ said ] the 1st thru/or the 4th [ said ] protection component have pn junction. And the p side of said pn junction connects said 1st protection component with said 1st magnetic shielding. The n side of said pn junction connects said 2nd protection component with said 1st magnetic shielding. The p side of said pn junction connects said 3rd protection component with said 2nd magnetic shielding. It is attained by the magnetic head of a publication of a publication by the 2nd invention characterized by the n side of said pn junction having connected said 4th protection component with said 2nd magnetic shielding. To the 4th, said 1st [ the ] pulls out said 1st protection component, and it intervenes between a conductor and said 1st magnetic shielding. Said 2nd [ the ] pulls out said 2nd protection component, and it intervenes between a conductor and said 1st magnetic shielding. Said 1st [ the ] pulls out said 3rd protection component, and it intervenes between a conductor and said 2nd magnetic shielding. It is attained by either the 1st characterized by intervening between a conductor and said 2nd magnetic shielding thru/or the 3rd invention by the magnetic head of a publication. said 4th protection component -- said 2nd cash drawer -- 5th with a magnetic resistance element The 3rd which draws the sense current which is connected to said magnetic resistance element, respectively, and flows into said magnetic resistance element, or flows out of said magnetic resistance element, and the 4th pull out. A conductor, The 3rd and 4th magnetic shielding which said magnetic resistance element, said 3rd [ the ], and said 4th [ the ] pull out through an insulator layer, and sandwiches a conductor, Said 5th protection component through which the 3rd or said 4th [ the ] pull out, connects with a conductor and said 3rd magnetic shielding, and it flows to the electrical potential difference beyond a convention, Said 3rd [ the ] or said 4th [ the ] pull out, and it connects with a conductor and said 4th magnetic shielding. It is attained by the magnetic head which has the 6th protection component through which it flows to the electrical potential difference beyond a convention. To the 6th said 5th and 6th protection components It is attained by the magnetic head of a publication by the 5th invention characterized by being diode, reference diode, or a varistor. In the 7th, both [ said ] the 5th and the 6th [ said ] protection component have pn junction. And the p side of said pn junction connects said 5th protection component with said 3rd magnetic shielding. It is attained by the magnetic head of a publication of a publication by the 6th invention characterized by the p side of said pn junction having connected said 6th protection component with said 4th magnetic shielding. To the 8th, said 3rd [ the ] or said 4th [ the ] pull out said 5th protection component, and it intervenes between a conductor and said 3rd magnetic shielding. Said 6th protection component It is attained by either the 5th characterized by intervening between a conductor and said 4th magnetic shielding thru/or the 7th invention by the magnetic head of a publication. said the 3rd or said 4th cash drawer -- It is attained by the magnetic recording medium which has the magnetic head given in the 1st, 2nd, 3rd, 5th, 6th, or 7th invention in the 9th. Said magnetic head is attached in a magnetic-head slider the 10th, and it is attained with the magnetic recording medium of a publication by the 9th invention characterized by connecting with wiring with which all of said 1st thru/or 4th protection component were pulled out to the exterior of said magnetic head. To the 11th Said magnetic head is attached in a magnetic-head slider, and it is attained with the magnetic recording medium of a publication by the 9th invention characterized by connecting with wiring with which all of said 5th and 6th protection components were pulled out by the exterior of said magnetic head. To the 12th The process which is attained by the magnetic recording medium which has the magnetic head of a publication in the 4th or 8th invention, and forms the 1st magnetic-shielding layer on an insulating substrate the 13th, The process which forms the 2nd protection component layer which consists of the 1st protection component layer which consists of a semi-conductor layer which has pn junction, and a semi-conductor layer which has pn junction on said 1st magnetic-shielding layer, respectively, The process which covers said the 1st, 2nd [ said ] protection component layer, and said 1st magnetic-shielding layer, and forms the 1st insulator layer, The process which carries out patterning of said 1st insulator layer, and forms the 1st and 2nd openings on said the 1st and said 2nd protection component layer, respectively, The process which forms the 1st cash-drawer conductor layer linked to said 1st protection component layer of said 1st opening pars basilaris ossis occipitalis, and forms the 2nd cash-drawer conductor layer linked to said 2nd protection component layer of the 2nd opening pars basilaris ossis occipitalis, The process which forms the magnetic-resistance-element layer linked to said the 1st and said 2nd cash-drawer conductor layer, The process which forms the 3rd protection component layer which consists of a semi-

conductor layer which has pn junction on said 1st cash-drawer conductor layer, and forms the 4th protection component layer which has pn junction on said 2nd cash-drawer conductor layer, The process which covers said the 3rd and said 4th protection component layer, said 1st [ the ], the 2nd [ said ] cash-drawer conductor layer, and said magnetic-resistance-element layer, and forms the 2nd insulator layer, The process which carries out patterning of said 2nd insulator layer, and forms the 3rd and 4th openings on said the 3rd and said 4th protection component layer, respectively, To the manufacture approach of the magnetic head of having the process which forms the 2nd magnetic-shielding layer which connects with said 3rd protection component layer of said 3rd opening pars basilaris ossis occipitalis, and connects with said 4th protection component layer of said 4th opening pars basilaris ossis occipitalis, and the process which covers said 2nd magnetic-shielding layer and forms the 3rd insulator layer It is attained and the p side of said pn junction connects said 1st protection component layer with said 1st magnetic-shielding layer the 14th. The n side of said pn junction connects said 2nd protection component layer with said 1st magnetic-shielding layer. The p side of said pn junction connects said 3rd protection component layer with said 2nd magnetic-shielding layer. It is attained by the manufacture approach of the magnetic head a publication by the 13th invention characterized by the n side of said pn junction having connected said 4th protection component layer with said 2nd magnetic-shielding layer. The process which forms the 3rd magnetic-shielding layer on an insulating substrate the 15th, The process which forms the 5th protection component layer which consists of a semi-conductor layer which has pn junction on said 3rd magnetic-shielding layer, The process which covers said 5th protection component layer and said 3rd magnetic-shielding layer, and forms the 4th insulator layer, The process which carries out patterning of said 4th insulator layer, and forms the 5th opening on said 5th protection component layer, The process which forms the 3rd and 4th cash-drawer conductor layers, and connects said 5th protection component layer of said 5th opening pars basilaris ossis occipitalis with either among said the 3rd and said 4th cash-drawer conductor layer, The process which forms the magnetic-resistance-element layer which connects with said the 3rd and said 4th cash-drawer conductor layer, respectively, The process which forms the 6th protection component layer which consists of a semi-conductor layer which has pn junction on said the 3rd or said 4th cash-drawer conductor layer, The process which covers said 6th protection component layer, said 3rd [ the ], the 4th [ said ] cash-drawer conductor layer, and said magnetic-resistance-element layer, and forms the 5th insulator layer, The process which carries out patterning of said 5th insulator layer, and forms the 6th opening on said 6th protection component layer, The process which forms the 4th magnetic-shielding layer linked to said 6th protection component layer of said 6th opening pars basilaris ossis occipitalis, It is attained by the manufacture approach of the magnetic head of having the process which covers said 4th magnetic-shielding layer and forms the 6th insulator layer. The p side of said pn junction connects said 5th protection component layer with said 3rd magnetic-shielding layer the 16th. Said 6th protection component layer is attained by the manufacture approach of the magnetic head a publication by the 15th invention characterized by the p side of said pn junction having connected with said 4th magnetic-shielding layer.

[0009]

[Function] In the magnetic head and the magnetic recording medium of this invention, the 1st and the 2nd pull out, and it connects with a conductor and the 1st magnetic shielding, respectively, and has the 1st [ through which it flows to the electrical potential difference beyond a convention ], and 2nd protection components, and the 3rd and 4th protection components which the 1st and the 2nd pull out, are connected to a conductor and the 2nd magnetic shielding, respectively, and flow to the electrical potential difference beyond a convention. As such 1st thru/or 4th protection component, use of diode, reference diode, or a varistor is possible.

[0010] Since the 1st or 2nd magnetic shielding has floated electrically, it is easy to be charged with static electricity. Since the 1st or the 2nd pull out and an electrical potential difference occurs between a conductor and the 1st or 2nd magnetic shielding, when either is charged at least, the 1st by the side of the 1st magnetic shielding, or the 2nd protection component -- or the 3rd by the side of the 2nd magnetic shielding or the 4th protection component -- flowing -- 1st magnetic-shielding -> -- the 1st or 2nd protection component -> 1st or 2nd cash drawer -- in the path of a conductor or 2nd magnetic-shielding -> -- protection component [ of the 3rd or \*\* a 4th ] -> -- the 1st or 2nd cash drawer -- static electricity discharges in the path of a conductor.

[0011] Therefore, if the electrostatic-discharge proof-pressure twist of the insulator layer which the 1st or the 2nd pull out the electrical potential difference through which the 2nd or 3rd protection component flows, and intervenes between a conductor and the 1st or 2nd magnetic shielding is also made small, destruction of the intervening insulator layer is avoidable. furthermore, the 1st or 2nd cash drawer -- the case where an excessive electrical-potential-difference surge takes a conductor -- the 1st and 2nd cash drawers of a magnetic resistance element -- a conductor -- the electrical-potential-difference difference of a between becomes large. the electrical-potential-difference difference which became large at this time -- any of the 1st thru/or 4th protection component -- although, since it flows the 1st or 2nd cash

drawer which is contained in the magnetic resistance element at juxtaposition -- conductor -> -- protection component -> 1st magnetic-shielding -> -- the 2nd or 1st protection component -> 2nd or 1st cash drawer -- for the path of a conductor [ of the 1st or \*\* a 2nd ] or the 1st or 2nd cash drawer -- conductor -> -- protection component [ of the 3rd or \*\* a 4th ] -> -- 2nd magnetic-shielding -> -- protection component [ of the 4th or \*\* a 3rd ] -> -- the 2nd or 1st cash drawer -- a superfluous current mainly flows for the path of a conductor, and it seldom flows to a magnetic resistance element.

[0012] moreover, the 1st or 2nd cash drawer -- the case where an excessive current surge takes a conductor -- the current -- a magnetic resistance element -- flowing -- the 1st and 2nd cash drawers -- a conductor, although the electrical-potential-difference difference of a between becomes large Since the 1st thru/or 4th protection component flows according to the electrical-potential-difference difference which became large, a magnetic resistance element and the 1st or 2nd cash drawer included in juxtaposition -- conductor -> -- protection component [ of the 1st or \*\* a 2nd ] -> -- 1st or 2nd magnetic-shielding -> -- the 2nd or 1st cash drawer -- in the path of a conductor or the 1st or 2nd cash drawer -- conductor -> -- protection component [ of the 3rd or \*\* a 4th ] -> -- 2nd magnetic-shielding -> -- protection component [ of the 4th or \*\* a 3rd ] -> -- the 2nd or 1st cash drawer -- a superfluous current is bypassed in the path of a conductor.

[0013] In any case, impression of the overvoltage to a magnetic resistance element or the inflow of an excessive current is avoidable. Moreover, the 3rd and the 4th pull out, and it connects with either and the 3rd magnetic shielding of a conductor, and has the 5th protection component through which it flows to the electrical potential difference beyond a convention, and the 6th protection component through which the 3rd and the 4th pull out, connects with either and the 4th magnetic shielding of a conductor, and it flows to the electrical potential difference beyond a convention.

[0014] therefore, the case where either of the 3rd or 4th magnetic shielding is charged -- the 5th or 6th protection component -- flowing -- 3rd or 4th magnetic-shielding -> -- the 5th or 6th protection component -> 3rd or 4th cash drawer -- static electricity discharges in the path of a conductor. Therefore, if the electrostatic-discharge proof-pressure twist of the insulator layer which the 3rd or the 4th pull out the electrical potential difference through which the 5th or 6th protection component flows, and intervenes between a conductor and the 3rd or 4th magnetic shielding is also made small, destruction of an insulator layer can be prevented.

[0015]

[Example] Hereafter, the example of this invention is explained, referring to a drawing.

(1) the explanation (a) about the magneto-resistive effect mold magnetic head (MR head) concerning the 1st thru/or the 3rd example of this invention -- the 1st example drawing 8 is the perspective view showing the magnetic recording medium with which the MR head concerning the 1st example of this invention was attached in the magnetic-head slider.

[0016] In drawing 8, 11 is an MR head, 12 is a magnetic-head slider, and MR head 11 is attached in the side attachment wall of the magnetic-head slider 12. 13 is a suspension which energizes the magnetic-head slider 12 to the direction of a magnetic disk 14. Information is the magnetic disk currently recorded magnetically and 14 rotates at high speed at the time of informational read-out.

[0017] Moreover, drawing 1 is the perspective view showing the detail of the MR head concerning the 1st example of this invention. In drawing 1, in order for 21 to supply a sense current to 22a and to supply band-like MR component layer with a thickness of about 340Å and 22b to MR component layer 21, the 1st which consists of a copper film of about 1000Å of thickness which connected with the both ends of MR component layer 21, and was prepared, and the 2nd pull out, and it is a conductor. a sense current -- for example, the 1st cash drawer -- MR component layer 21 from conductor 22a -- flowing -- MR component layer 21 -- passing -- the 2nd cash drawer from MR component layer 21 -- a conductor -- it flows into 22b.

[0018] 23a and 23b are the 1st and 2nd plate-like magnetic shielding, about 2-3 micrometers in a soft magnetic material, for example, thickness it is thin from a permalloy, which MR component layer 21, the 1st, and the 2nd pulled out through the non-illustrated insulator layer, and was prepared on both sides of Conductors 22a and 22b. Spacing between the 1st and 2nd magnetic-shielding 23a and 23b is about 0.35 micrometers. It is the 1st thru/or the 4th diode formed in order to bypass an excessive current and the discharge current by electrified static electricity 24a-24d. 1st diode 24a -- the 1st cash drawer -- a conductor -- it connects with 22a and 1st magnetic-shielding 23a -- having -- 2nd diode 24b -- the 2nd cash drawer -- a conductor -- it connects with 22b and 1st magnetic-shielding 23a. moreover, 3rd diode 24c -- the 1st cash drawer -- a conductor -- it connects with 22a and 2nd magnetic-shielding 23b -- having -- 4th diode 24d -- the 2nd cash drawer -- a conductor -- it connects with 22b and 2nd magnetic-shielding 23b. Detailed connection relation is described below.

[0019] Drawing 3 is the circuit diagram showing the surrounding electrical installation of the MR head concerning the

1st example of this invention. the 1st cash drawer -- a conductor -- the sense current-supply circuit 25 connects with 22a -- having -- the 2nd cash drawer -- a conductor -- 22b is grounded. a sense current -- the 1st cash drawer -- the 2nd cash drawer from conductor 22a -- a conductor -- it flows to the direction of 22b. Moreover, the 1st and the 2nd pull out and Conductors 22a and 22b are connected to the regenerative circuit 27 through the capacitors 26a and 26b for a direct-current cut, respectively.

[0020] the 1st cash drawer -- a conductor -- an anode connects to 1st magnetic-shielding 23a 1st diode (1st protection component) 24a which intervenes between 22a and 1st magnetic-shielding 23a -- having -- the 1st cash drawer -- a conductor -- the cathode is connected to 22a. the 2nd cash drawer -- a conductor -- a cathode connects to 1st magnetic-shielding 23a 22b and 2nd diode (2nd protection component) 24b which intervenes between 1st magnetic-shielding 23a -- having -- the 2nd cash drawer -- a conductor -- the anode is connected to 22b.

[0021] the 1st cash drawer -- a conductor -- a cathode connects to 2nd magnetic-shielding 23b 3rd diode (3rd protection component) 24c which intervenes between 22a and 2nd magnetic-shielding 23b -- having -- the 1st cash drawer -- a conductor -- the anode is connected to 22a. the 2nd cash drawer -- a conductor -- an anode connects with 2nd magnetic-shielding 23b 4th diode (4th protection component) 24d which intervenes between 22b and 2nd magnetic-shielding 23b -- having -- the 2nd cash drawer -- a conductor -- the cathode is connected to 22b.

[0022] in addition -- although an electrical potential difference occurs to the both ends of MR component layer 21 at the time of the usual actuation since the resistance of MR component layer 21 is passing 10-20mA of sense currents in MR component layer 21 by about 5-10ohms -- at most -- it is about 0.2V. Therefore, even if the above-mentioned diodes 24a-24d are connected, it does not have any effect on actuation of a magnetic recording medium, either.

Informational read-out is performed as follows from a magnetic disk 14 using above-mentioned MR head 21. That is, if a magnetic disk 14 is rotated as shown in drawing 8, the magnetic-head slider 12 will come floating on a magnetic disk 14, and will maintain a submicron spacing from the front face of a magnetic disk 14 by balance of the surfacing force and the thrust by the suspension 13. And MR head 11 detects the signal magnetic flux from a magnetic disk 14.

[0023] MR component layer 21 -- the 1st cash drawer -- the 2nd cash drawer from conductor 22a -- a conductor -- 10-20mA of sense currents is beforehand passed toward 22b, and if signal magnetic flux goes into MR component layer 21, the resistance of MR component layer 21 changes, and it will become change of an electrical potential difference and will appear. This is taken out through a regenerative circuit. Next, the actuation which makes overvoltage, an excessive current, and the discharge current by electrified static electricity bypass is explained using the above-mentioned magnetic head, referring to drawing 2 (a), (c), and drawing 3.

[0024] Drawing 2 (a) is the connection diagram showing the electrical installation relation of the protection component within the magnetic head. Drawing 2 (c) is the property Fig. showing the 1st - diode [ 4th /a / 24 /-24d ] current-voltage characteristic as a protection component. Since the 1st or 2nd magnetic shielding 23a and 23b, the 1st, or the 2nd pull out and an electrical potential difference occurs among Conductors 22a and 22b, when the 1st or 2nd magnetic shielding 23a and 23b is charged, the 2nd or 3rd diode 24b and 24c -- flowing -- the 1st or 2nd magnetic-shielding 23a, 23b-> 2nd or 3rd diode 24b, and the 24c-> 1st or 2nd cash drawer -- static electricity discharges in the path of Conductors 22a and 22b.

[0025] By the way, the electrical potential difference through which the 2nd or 3rd diode 24b and 24c flows is about 0.6V, and the dielectric-breakdown proof-pressure twist of the insulator layer which the 1st or the 2nd pull out and intervenes between Conductors 22a and 22b and the 1st or 2nd magnetic shielding 23a and 23b also becomes small. For this reason, destruction of an insulator layer can be prevented. moreover, the 1st cash drawer -- a sense current is flowed into MR component layer 21 from conductor 22a -- making -- the 2nd cash drawer from MR component layer 21 -- a conductor -- the case where an excessive electrical potential difference or an excessive current occurs while making the sense current flow into 22b -- the electrical potential difference -- the 1st cash drawer -- a conductor -- the 22a side -- high -- the 2nd cash drawer -- a conductor -- the 22b side becomes low. or the current -- the 1st cash drawer -- a conductor -- the 2nd cash drawer from the 22a side -- a conductor -- it flows to the 22b side.

[0026] furthermore, the 1st cash drawer -- a conductor -- the case where an excessive electrical-potential-difference surge is in 22a -- the 1st and 2nd cash drawers of a magnetic resistance element -- the electrical-potential-difference difference between conductor 22a and 22b becomes large. at this time, that electrical-potential-difference difference becomes large -- any of the 1st and 2nd diodes 24a and 24b -- although -- the 1st cash drawer which is contained in MR component layer 21 at juxtaposition since it flows -- conductor 22a-> -- 1st diode 24a-> 1st magnetic-shielding 23a-> -- the 2nd diode 24b-> 2nd cash drawer -- a conductor -- a superfluous current flows for the path of 22b, and it seldom flows to a magnetic resistance element.

[0027] Moreover, although the current flows in MR component layer 21, the 1st and the 2nd pull out and the electrical potential difference between conductor 22a and 22b rises when the 1st or the 2nd pull out and an excessive current



surge takes Conductors 22a and 22b the rise of the electrical potential difference -- any of the 1st and 2nd diodes 24a and 24b -- although, since it flows MR component layer 21 and the 1st cash drawer included in juxtaposition -- conductor 22a-> -- 1st diode 24a-> 1st magnetic-shielding 23a-> -- the 2nd diode 24b-> 2nd cash drawer -- a conductor -- a superfluous current is bypassed in the path of 22b.

[0028] the above and reverse -- the 2nd cash drawer -- a sense current is flowed into MR component layer 21 from conductor 22b -- making -- the 1st cash drawer from MR component layer 21 -- a conductor -- the case where an excessive electrical potential difference or an excessive current occurs while making the sense current flow into 22a -- the electrical potential difference -- the 2nd cash drawer -- a conductor -- the 22b side -- high -- the 1st cash drawer -- a conductor -- the 22a side becomes low. or the current -- the 2nd cash drawer -- a conductor -- the 1st cash drawer from the 22b side -- a conductor -- it flows to the 22a side. therefore, the 2nd cash drawer -- a conductor -- -> 4th diode 24d - -> 2nd magnetic-shielding 23b-> -- the 3rd diode 24c-> 1st cash drawer -- a conductor -- a superfluous current flows for the path of 22a, and it seldom flows in MR component layer 21.

[0029] In any case, the overvoltage to MR component layer 21 or impression of an excessive current is avoidable. As mentioned above, according to the magnetic head of the example of this invention, the magnetic head strong against a surge or static electricity can be offered, and the handling of the magnetic head becomes easy. In addition, as shown in drawing 2 (b), connection of the 1st and 2nd diodes 24a and 24b is left as it is as the example, and the 3rd and 4th diodes 24c and 24d may be connected [ both ] to an example and reverse.

[0030] Moreover, connection of the 3rd and 4th diodes 24c and 24d is left as it is as the example, and the 1st and 2nd diodes 24a and 24b may connect it to an example and reverse. Furthermore, the 1st and 4th diodes 24a and 24d shown in drawing 2 (a) may be removed, and as shown in drawing 6 (a), it may leave only the 2nd and 3rd diodes 24b and 24c. In this case, when the 1st or 2nd magnetic shielding 23a and 23b is charged, the 1st or the 2nd can pull out through the 2nd or 3rd diode 24b and 24c, and Conductors 22a and 22b can be made to discharge.

[0031] (b) The 2nd example drawing 4 (a) is the perspective view showing the connection-related detail of the protection component of the MR head concerning the 2nd example of this invention. A different place from drawing 2 (a) is using reference diodes 31a-31d instead of diode as a protection component. In this case, as shown in the current-voltage characteristic of drawing 4 (c), as compared with diode, the breakdown voltage of hard flow can also create a small thing. For example, about 5V is possible. The 1st and the 2nd pull out and the 4th the 1st - reference diodes [ 31a-31d ] connection relation to Conductors 22a and 22b and the 1st and 2nd magnetic shielding 23a and 23b is the same as the case of drawing 2 (a).

[0032] Therefore, also when the overvoltage of hard flow is impressed to the 1st - the 4th reference diode 31a-31d, before the case where the electrical potential difference is diode becomes high, it flows. For this reason, when a surge and static electricity arise, the overvoltage impressed to MR component or the value of an excessive current can be made smaller than the case of the 1st example. In addition, as shown in drawing 4 (b), the 4th connection of the 1st - reference diodes 31a and 31b is left as it is as the example, and the 3rd and 4th reference diodes 31c and 31d may be connected [ both ] to an example and reverse.

[0033] Moreover, connection of the 3rd and 4th reference diodes 31c and 31d is left as it is as the example, and the 1st and 2nd reference diodes 31a and 31b may connect it to an example and reverse. Furthermore, the 1st and 4th reference diodes 32a and 32d shown in drawing 4 (a) may be removed, and as shown in drawing 6 (b), it may leave only the 2nd and 3rd reference diodes 32b and 32c. In this case, when the 1st or 2nd magnetic shielding 23a and 23b is charged, the 1st or the 2nd can pull out through the 2nd or 3rd reference diode 32b and 32c, and Conductors 22a and 22b can be made to discharge.

[0034] (c) The 3rd example drawing 5 (a) is the perspective view showing the connection-related detail of the protection component of the MR head concerning the 3rd example of this invention. A different place from drawing 2 (a) and drawing 4 (a) is using the 1st - the 4th varistor 32a-32d instead of diode and reference diode as a protection component. In this case, as shown in the current-voltage characteristic of drawing 5 (b), as compared with diode and reference diode, the electrical potential difference which the current-voltage characteristic of the forward direction and hard flow has the almost same form, and flows is also almost the about the same as the forward voltage of diode and reference diode. For example, it is about 0.6V. For this reason, unlike drawing 2 (a) and drawing 4 (a), it is not necessary to make special connection in consideration of a polarity.

[0035] Therefore, also when the overvoltage of hard flow is impressed to the 1st - the 4th varistor 32a-32d, the flowing electrical potential difference becomes still smaller than diode and reference diode. For this reason, rather than the case of the 1st and 2nd examples, the overvoltage impressed to MR component layer 21 or the value of an excessive current can be made smaller, and the protective effect of MR component layer 21 becomes still larger.

[0036] In addition, since it has the current-voltage characteristic with same forward direction and hard flow when the



1st - the 4th varistor 32a-32d are used, it is not necessary to make connection reverse like the 1st and 2nd examples.

(2) Explain the manufacture approach of the MR head concerning the 4th example of this invention, referring to the 4th example of the explanation (a) about the manufacture approach of the MR head and magnetic recording medium concerning the example of this invention, next drawing 1.

[0037] First, it creates to the 1st magnetic-shielding 23a which consists of permalloy film according to the usual process on the side attachment wall of the magnetic-head slider 12 shown in drawing 8. Subsequently, the polish recon film is deposited with a CVD method etc. on magnetic-shielding 23a. Then, the mask of the polish recon film of one side on magnetic-shielding 23a is carried out, a P type impurity and an N type impurity are introduced into the polish recon film, and pn junction is formed. Then, the mask of the polish recon film of one side on magnetic-shielding layer 23b is carried out, an N type impurity and a P type impurity are introduced into the polish recon film, and pn junction is formed.

[0038] Subsequently, patterning of the polish recon film is carried out, and the 1st and 2nd diodes 24a and 24b are created. Next, after covering the 1st and 2nd diodes 24a and 24b and forming silicon oxide, MR component layer 21 is formed on silicon oxide. Then, patterning of the silicon oxide is carried out and opening is formed on the 1st and 2nd diode 24a and 24b. In addition, silicon oxide is not illustrating.

[0039] Subsequently, patterning of the copper film is formed and carried out, the 1st linked to the 1st and 2nd diodes 24a and 24b and the 2nd pull out, and Conductors 22a and 22b are formed. Next, after the 1st and the 2nd pulling out with a CVD method etc., covering Conductors 22a and 22b and depositing the polish recon film, like the above, a P type impurity and an N type impurity are introduced into the polish recon film, and pn junction is formed. Then, patterning is carried out, the 1st and the 2nd pull out, and the 3rd and 4th diodes 24c and 24d are created on conductor 22a and 22b, respectively.

[0040] Subsequently, after covering the 3rd and 4th diodes 24c and 24d and forming silicon oxide, patterning is carried out and opening is formed on the 3rd and 4th diode 24c and 24d. Then, 2nd magnetic-shielding 23b of another side which deposits and carries out patterning of the permalloy film, and is connected with the 3rd and 4th diodes 24c and 24d is formed. In addition, silicon oxide is not illustrating.

[0041] Then, formation of the covering insulator layer which is not illustrated completes the magnetic head 11. As mentioned above, according to the 4th example of this invention, since a protection component can be made to build in the magnetic head 11 using a semi-conductor process, a miniaturization can be maintained and the magnetic head strong against surge current or static electricity can be offered.

(b) Explain the manufacture approach of the magnetic recording medium concerning the 5th example of this invention, referring to the 5th example, next drawing 7.

[0042] In case the 1st and the 2nd pull out and Conductors 22a and 22b are formed in the production process of the 4th example And in case the 1st and 2nd magnetic shielding 23a and 23b is formed, the 1st and the 2nd pull out and it connects with Conductors 22a and 22b and the 1st and 2nd magnetic shielding 23a and 23b, respectively. Four band-like wiring layers 22c, 22d, 23c, and 23d pulled out by the exterior of magnetic-head 11a are formed in the side attachment wall of magnetic-head slider 12a. As a wiring layers [ 22c, 22d 23c, and 23d ] ingredient, the 1st and the 2nd may pull out, the same conductor as Conductors 22a and 22b and the 1st and 2nd magnetic shielding 23a and 23b may be used, and a different conductor may be used.

[0043] Subsequently, magnetic-head 11a is formed through the process shown in the 4th example. In addition, unlike the 4th example, in magnetic-head 11a, a protection component is not formed in this case. then, it becomes the same connection as connection of drawing 5 -- as -- 1st magnetic-shielding 23a and the 1st cash drawer -- a conductor -- between 22a 1st magnetic-shielding 23a and the 2nd cash drawer -- a conductor -- between 22b, and 2nd magnetic-shielding 23b and the 1st cash drawer -- a conductor -- between 22a, and 2nd magnetic-shielding 23b and the 2nd cash drawer -- a conductor -- the protection component separately created between 22b, respectively -- for example, the 1- a varistor component [ 4th /a / 33 /-33d ] external terminal is connected.

[0044] As mentioned above, the protection components 33a-33d can be separately attached in the exterior of magnetic-head 11a. Thereby, a magnetic recording medium strong against surge current or static electricity can be offered.

[0045]

[Effect of the Invention] In the magnetic head and the magnetic recording medium of this invention, the 1st and the 2nd pull out, and it connects with a conductor and the 1st magnetic shielding, respectively, and has the 1st [ through which it flows to the electrical potential difference beyond a convention ], and 2nd protection components, and the 3rd and 4th protection components which the 1st and the 2nd pull out, are connected to a conductor and the 2nd magnetic shielding, respectively, and flow to the electrical potential difference beyond a convention.

[0046] Therefore, since the 1st or the 2nd pull out from the 1st or 2nd magnetic shielding and static electricity

discharges certainly to a conductor through the 1st thru/or 4th protection component when the 1st or 2nd magnetic shielding is charged, destruction of the intervening insulator layer is avoidable. furthermore, the 1st or 2nd cash drawer -- the case where an excessive electrical-potential-difference surge or a current surge takes a conductor -- protection component -> 1st magnetic-shielding -> -- the path of the 2nd or 1st protection component -- it is -- or protection component -> 2nd magnetic-shielding -> -- a superfluous current can be made to bypass in the path of the 4th or 3rd protection component [ of the 1st or \*\* a 2nd ] [ of the 3rd or \*\* a 4th ]

[0047] Therefore, impression of the overvoltage to a magnetic resistance element or the inflow of an excessive current can be avoided, and the magnetic head strong against a surge or static electricity can be offered. Moreover, the 3rd and the 4th pull out, and it connects with either and the 3rd magnetic shielding of a conductor, and has the 5th protection component through which it flows to the electrical potential difference beyond a convention, and the 6th protection component through which the 3rd and the 4th pull out, connects with either and the 4th magnetic shielding of a conductor, and it flows to the electrical potential difference beyond a convention.

[0048] Since the 3rd or the 4th pull out from the 3rd or 4th magnetic shielding through the 5th or 6th protection component and static electricity discharges to a conductor when either of the 3rd or 4th magnetic shielding is charged, the electrostatic discharge of the intervening insulator layer can be prevented. Therefore, electrification of magnetic shielding can be made to be able to discharge certainly and the magnetic head strong against static electricity can be offered.

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[Translation done.]